Observing the Upper Flat Band in Pentalayer Rhombohedral Graphene Using Nano-ARPES via Electrical Gating

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Abstract

Most recently, researchers have discovered that even in non-twisted multilayer graphene, many intriguing and complex collective behaviours, especially superconductivity, can be induced by applying external fields and doping [1]. Specifically, ABC-stacked (or rhombohedral) multilayer graphene naturally exhibits a flat band near the Fermi level, providing an ideal platform for interaction-driven collective phenomena, including the fractional quantum anomalous Hall effect [2] and chiral superconductivity [3]. In this work, we successfully electrically gated a pentalayer rhombohedral graphene sample and observed its upper flat band using nano angle-resolved photoemission spectroscopy (nano-ARPES). We recorded the evolution of the energy gap separating the lower and upper flat bands as the strength of the external electric field gradually increased to approximately 0.4 V/nm.

References

[1] P.A. Pantaleón, et al., Nat. Rev. Phys., 5 (2023) 304–315
[2] Z. Lu, et al., Nature, 8000 (2024) 759-764
[3] T. Han, et al., Nature, 8072 (2025) 654-661

Figures

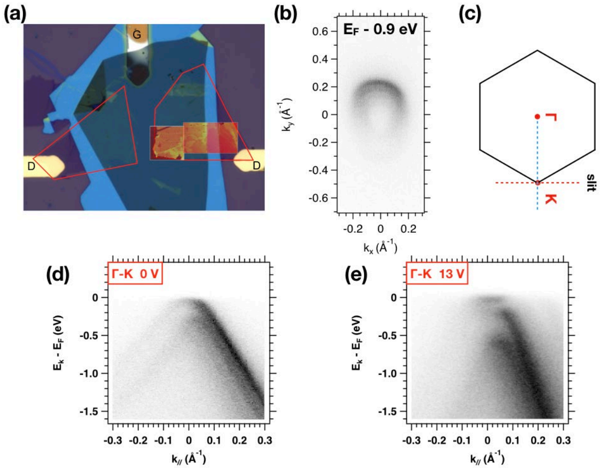

Figure 1: (a) Optical image of the measured sample. Red lines indicate the borders of the pentalayer graphene flakes. SNOM scans taken after the nano-ARPES measurement are overlaid, with yellow indicating the ABC stacking. (b) Constant energy contour 0.9 eV below the Fermi level, with the K point shifted to (0, 0). (c) Sketch of the Brillouin zone and the orientation corresponding to (b). (d-e) Energy-momentum spectra along Γ-K (blue dashed line in (c)) measured without and with a gating voltage of 13 V, respectively.